Amendments to the Claims:

This listing of claims replaces all prior versions and listings of claims in the application:

Listing of Claims:

1. (Original) A method of quantitative determination of the phase of a radiation wave field including the steps of

(a) producing a representative measure of the rate of change of intensity of said radiation wave field over a selected surface extending generally across the wave field;

(b) producing a representative measure of intensity of said radiation wave filed over said selected surface;

(c) transforming said measure of rate of change of intensity to produce a first integral transform representation and applying to said first integral transform representation a first filter corresponding to the inversion of a first differential operator reflected in said measure of rate of change of intensity to produce a first modified integral transform representation;

(d) applying an inverse of said first integral transform to said first modified integral transform representation to produce an untransformed representation;

(e) applying a correction based on said measure of intensity over said selected surface to said untransformed representation;

(f) transforming the corrected untransformed representation to produce a second integral transform representation and applying to said second integral transform representation a second filter corresponding to the inversion of a second differential operator reflected in the corrected untransformed representation to produce a second modified integral transform representation;

(g) applying an inverse of said second integral transform to said second modified integral transform representation to produce a measure of phase of said radiation wave field across said selected plane.

2. (Original) A method as claimed in claim 1 wherein said first and second integral transforms are produced using a Fourier transform.

3. (Original) A method as claimed in claim 2 where said Fourier transform is a Fast Fourier transform.

4. (Previously Presented) A method as claimed in claim 1 wherein said first and second differential operators are second order differential operators.

5. (Previously Presented) A method as claimed in claim 1 wherein said first filter is substantially the same as said second filter.

6. (Previously Presented) A method as claimed in claim 1 wherein said first filter includes selectively suppressing first higher frequencies of the first integral transform representation.

7. (Previously Presented) A method as claimed in claim 1 wherein at least one of said first and second filters includes a correction for noise in said representative measure of intensity.

8. (Previously Presented) A method as claimed in claim 1 including the step of producing said representative measures of intensity and rate of change of intensity over said selected surface by producing representative measurements corresponding to intensity over at least two spaced apart surfaces extending across the wave field.

9. (Original) A method as claimed in claim 8 wherein said selected surface is between two of said spaced apart surfaces.

10. (Original) A method as claimed in claim 8 wherein said selected surface is one of said spaced apart surfaces.

11. (Previously Presented) A method as claimed in claim 8 including the step of directly detecting representative measures of intensity over said spaced apart surfaces.

12. (Previously Presented) A method as claimed in claim 8 including the step of producing said representative measure of intensity over at least one of said spaced apart surfaces by imaging that surface.

13. (Previously Presented) A method as claimed in claim 8 wherein said spaced apart surfaces are substantially parallel.

14. (Original) A method as claimed in claim 13 wherein said spaced apart surfaces are substantially planar.

15. (Previously Presented) A method as claimed in claim 8 wherein said representative measure of rate of change of intensity is produced by subtraction of representative measurements of intensity respectively made at locations over said spaced apart surfaces.

16. (Previously Presented) A method as claimed in claim 1 wherein said representative measures of intensity and rate of change of intensity are obtained by sampling measurements at selected locations over said surface.

17. (Original) A method as claimed in claim 16 wherein said sampling measurements are made at locations defining a regular array over said surface.

18. (Previously Presented) A method as claimed in claim 2 wherein said radiation wave field propagates in a z-direction of a Cartesian co-ordinate system and further including the step of producing an x component and a y component of phase separately.

19. (Original) A method as claimed in claim 18 wherein said first and said second filters have a component Ω_x for producing the x component of phase and a component Ω_y for

$$\Omega_x = \frac{(k_x^2 + k_y^2)k_x}{(k_x^2 + k_y^2)^2 + \alpha k_x^2}$$

$$\Omega_y = \frac{(k_x^2 + k_y^2)k_y}{(k_x^2 + k_y^2)^2 + \alpha k_y^2}$$

producing the y component of the phase of the form

where k_x, k_y are the Fourier variables conjugate to x and y;
α is a constant determined by noise in the intensity measurements.

20. (Original) A method as claimed in claim 19 including the step of multiplying said representative measure of rate of change of intensity by the negative of average wave number of the radiation before said integral transformation.

21. (Previously Presented) A method as claimed in claim 1 including the step of obtaining said representative measure of rate of change of intensity by obtaining a first representative measurement over a measurement surface across the wave field for radiation of a

first energy and obtaining a second representative measurement over said measurement surface for radiation of a second different energy.

22. (Previously Presented) A method as claimed in claim 2 wherein at least one of said first filter and said second filter include a correction for aberrations in said representative measures of intensity and rate of change of intensity by including at least one component dependent on the aberration, coefficients of a system producing the representative measures.

23. (Original) A method as claimed in claim 22 wherein said radiation wave field propagates in a z-direction of a Cartesian co-ordinate system and further including the step of producing an x component and a y component of phase separately.

24. (Original) A method as claimed in claim 23 wherein said first and said second filters have a component Ω_x for producing the x component of phase and a component Ω_y for producing the y component of phase both of the form

$$\frac{1}{\sqrt{-4\pi\delta z\bar{\lambda}(k_x^2+k_y^2)-4\sum_m\sum_n A_{mn}k_x^m k_y^n}}$$

where k_x, k_y are the Fourier variables conjugate to x and y;

$\bar{\lambda}$ is the average wave length of the radiation;

$_{\text{aberrated}}(x,y)$ is the aberrated intensity measured at defocus distance δz,

A_{mn} are the aberration coefficients which characterize the imperfect imaging system.

25. (Cancelled)

26. (Cancelled)

27. (Original) An apparatus for quantitative determination of the phase of a radiation wave field including

(a) means to produce a representative measure of the rate of change of intensity of said radiation wave field over a selected surface extending generally across the wave field;

(b) means to produce a representative measure of intensity of said radiation wave field over said selected surface;

(c) processing means to sequentially

(I) transform said measure of rate of change of intensity to produce a first integral transform representation;

(II) apply to said first integral transform representation a first filter corresponding to the inversion of a first differential operator reflected in said measure of rate of change of intensity to produce a first modified integral transform representation;

(III) apply an inverse of said first integral transform to said first modified integral transform representation to produce an untransformed representation;

(IV) apply a correction based on said measure of intensity over said selected surface to said untransformed representation;

(V) transform the corrected untransformed representation to produce a second integral transform representation;

(VI) apply to said second integral transform representation a second filter corresponding to the inversion of a second differential operator reflected in the corrected untransformed representation to produce a second modified integral transform representation; and

(VII) apply an inverse of said second integral transform to said second modified integral transform representation to produce a measure of phase of said radiation wave field across said selected plane.

28. (Original) An apparatus as claimed in claim 27 wherein said first and second integral transforms are produced using a Fourier transform.

29. (Original) An apparatus as claimed in claim 28 wherein said Fourier transform is a Fast Fourier transform.

30. (Previously Presented) An apparatus as claimed in claim 27 wherein said first and second differential operators are second order differential operators.

31. (Previously Presented) An apparatus as claimed in claim 27 wherein said first filter is substantially the same as said second filter.

32. (Previously Presented) An apparatus as claimed in claim 27 wherein said first filter includes selectively suppressing first higher frequencies of the first integral transform representation.

33. (Previously Presented) An apparatus as claimed in claim 27 wherein at least one of said first and second filters includes a correction for noise in said representative measure of intensity.

34. (Previously Presented) An apparatus as claimed in claim 27 including means to produce representative measurements corresponding to intensity over at least two spaced apart surfaces extending across the wave field.

35. (Original) An apparatus as claimed in claim 34 wherein said selected surface is between two of said spaced apart surfaces.

36. (Original) An apparatus as claimed in claim 34 wherein said selected surface is one of said spaced apart surfaces.

37. (Previously Presented) An apparatus as claimed in claim 34 including detector means positioned to directly detect representative measures of intensity over said spaced apart surfaces.

38. (Previously Presented) An apparatus as claimed in claim 34 including detector means to produce said representative measure of intensity over at least one of said spaced apart surfaces and imaging means to image that surface onto the detector.

39. (Previously Presented) An apparatus as claimed in claim 34 wherein said spaced apart surfaces are substantially parallel.

40. (Previously Presented) An apparatus as claimed in claim 34 wherein said spaced apart surfaces are substantially planar.

41. (Previously Presented) An apparatus as claimed in claim 34 wherein said means to produce said representative measure of rate of change of intensity subtracts representative measurements of intensity respectively made at locations over said spaced apart surfaces.

42. (Previously Presented) An apparatus as claimed in claim 27 wherein said means to produce a representative measure of intensity and said means to produce a representative measure of rate of change of intensity sample at selected locations over said surface.

43. (Original) An apparatus as claimed in claim 42 wherein said samples are made at locations defining a regular array over said surface.

44. (Previously Presented) An apparatus as claimed in claim 28 wherein said radiation wave field propagates in a z-direction of a Cartesian co-ordinate system and processing means produces an x component and a y component of phase separately.

45. (Original) An apparatus as claimed in claim 44 wherein said processing means applies said first and said second filters have a component Ω_x for producing the x component of phase and a component Ω_y for producing the y component of phase of the form

$$\Omega_x = \frac{(k_x^2 + k_y^2)k_x}{(k_x^2 + k_y^2)^2 + \alpha k_x^2}$$

$$\Omega_y = \frac{(k_x^2 + k_y^2)k_y}{(k_x^2 + k_y^2)^2 + \alpha k_y^2}$$

where k_x, k_y are the Fourier variables conjugate to x and y;
α is a constant determined by noise in the intensity measurements.

46. (Original) An apparatus as claimed in claim 37 wherein said representative measure of rate of change of intensity is multiplied by the negative of the average wave number of the radiation before said integral transformation.

47. (Previously Presented) An apparatus as claimed in claim 27 wherein said representative measure of rate of change of intensity is produced by obtaining a first representative measurement over a measurement surface across the wave field for radiation of a

first energy and obtaining a second representative measurement over said measurement surface for radiation of a second different energy.

48. (Previously Presented) An apparatus as claimed in claim 28 wherein at least one of said first filter and said second filter include a correction for aberrations in said representative measures of intensity and rate of change of intensity by including at least one component dependent on the aberration, coefficients of a system producing the representative measures.

49. (Original) An apparatus as claimed in claim 48 wherein said radiation wave field propagates in a z-direction of a Cartesian co-ordinate system and wherein an x component and a y component of phase are produced separately.

50. (Original) An apparatus as claimed in claim 49 where in said first and said second filters have a component Ω_x for producing the x component of phase and a component Ω_y for producing the y component of phase both of the form

$$\frac{1}{\sqrt{-4\pi.\delta z.\bar{\lambda}(k_x^2+k_y^2)-4\sum_m \sum_n A_{mn} k_x^m k_y^n}}$$

where k_x, k_y are the Fourier variables conjugate to x and y;

$\bar{\lambda}$ is the average wave length of the radiation;

$I_{aberrated}$ (x,y) is the aberrated intensity measured at defocus distance δz,

A_{mn} are the aberration coefficients which characterize the imperfect imaging system.

51. (Original) A method of imaging an object including the steps of

(a) exposing the object to a radiation wave field from a source;

(b) producing a representative measure of the rate of change of intensity over a selected surface extending generally across the wave field on the side of the object remote from incident radiation;

(c) producing a representative measure of intensity of said radiation wave field over said selected surface;

(d) transforming said measure of rate of change of intensity to produce a first integral transform representation and applying to said first integral transform representation and applying to said first integral transform representation a first filter corresponding to the inversion of a first differential operator reflected in said measure of rate of change of intensity to produce a first modified integral transform representation;

(e) applying an inverse of said first integral transform to said first modified integral transform representation to produce an untransformed representation;

(f) applying a correction based on said measure of intensity over said selected surface to said untransformed representation;

(g) transforming the corrected untransformed representation to produce a second integral transform representation and applying to said second integral transform representation a second filter corresponding to the inversion of a second differential operator reflected in eh corrected untransformed representation to produce a second modified integral transform representation;

(h) applying an inverse of said second integral transform to said second modified integral transform representation to produce a measure of phase of said radiation wave field across said selected plane.

52. (Original) A method as claimed in claim 51 including the step of producing said representative measures of intensity and rate of change of intensity over said selected surface by producing representative measurements corresponding to intensity over at least two spaced apart surfaces extending across the wave field.

53. (Original) A method as claimed in claim 52 wherein said selected surface is between two of said spaced apart surfaces.

54. (Original) A method as claimed in claim 52 wherein said selected surface is one of said spaced apart surfaces.

55. (Previously Presented) A method as claimed in claim 52 wherein said spaced apart surfaces are substantially parallel.

56. (Previously Presented) A method as claimed in claim 52 wherein said spaced apart surfaces are substantially planar.

57. (Previously Presented) A method as claimed in claim 52 wherein said representative measure of rate of change of intensity is produced by subtraction of representative measurements of intensity respectively made at locations over said spaced apart surfaces.

58. (Original) A method as claimed in claim 51 including the step of producing said measures of intensity and rate of change of intensity over said selected surface by producing first representative measurements corresponding to intensity over a first surface extending across the wave field, changing the distance between said source and said object, and producing second representative measurements corresponding to intensity over said first surface for the changed distance between said object and said source.

59. (Original) A method as claimed in claim 58 wherein said selected surfaces is one of said spaced apart surfaces.

60. (Previously Presented) A method as claimed in claim 51 including the step of directly detecting representative measures of intensity over said spaced apart surfaces.

61. (Previously Presented) A method as claimed in claim 51 wherein said selected surface is spaced apart from said object in the direction of propagation of said radiation.

62. (Previously Presented) A method as claimed in claim 51 wherein said source is substantially a point source.

63. (Previously Presented) A method as claimed in claim 51 wherein said first and second integral transforms are produced using a Fourier transform.

64. (Previously Presented) A method as claimed in claim 51 wherein said Fourier transform is a Fast Fourier transform.

65. (Original) An apparatus for imaging an object including:

(a) a source to irradiate the object with a radiation wave field;

(b) means to produce a representative measure of the rate of change of intensity of said radiation wave field over a selected surface extending generally across the wave field.

(c) means to produce a representative measure of intensity of said radiation wave field over said selected surface;

(d) processing means to sequentially

(i) transform said measure of rate of change of intensity of produce a first integral transform representation;

(ii) apply to said first integral transform representation a first filter corresponding to the inversion of a first differential operator reflected in said measure of rate of change of intensity to produce a first modified integral transform representation;

(iii) apply an inverse of said first integral transform to said first modified integral transform representation to produce an untransformed representation;

(iv) apply a correction based on said measure of intensity over said selected surface to said untransformed representation;

(v) transform the corrected untransformed representation to produce a second integral transform representation;

(vi) apply to said second integral transform representation a second filter corresponding to the inversion of a second differential operator reflected in the corrected untransformed representation to produce a second modified integral transform representation; and

(vii) apply an inverse of said second integral transform to said second modified integral transform representation to produce a measure of phase of said radiation wave field across said selected plane.

66. (Original) An apparatus as claimed in claim 65 including means to produce representative measurements corresponding to intensity over at least two spaced apart surfaces extending across the wave field.

67. (Original) An apparatus as claimed in claim 66 wherein said selected surface is between two of said spaced apart surfaces.

68. (Original) An apparatus as claimed in claim 66 wherein said selected surface is one of said spaced apart surfaces.

69. (Previously Presented) An apparatus as claimed in claim 66 including detector means positioned to directly detect representative measures of intensity over said spaced apart surfaces.

70. (Previously Presented) An apparatus as claimed in claim 66 including detector means to produce said representative measure of intensity over at least one of said spaced apart surfaces and imaging means to image that surface onto the detector.

71. (Previously Presented) An apparatus as claimed in claim 66 wherein said spaced apart surfaces are substantially parallel.

72. (Previously Presented) An apparatus as claimed in claim 66 wherein said representative measure of rate of change of intensity is produced by subtraction of representative measurements of intensity respectively made at locations over said spaced apart surfaces.

73. (Original) An apparatus as claimed in claim 65 including means to produce said measures of intensity and rate of change of intensity overs said selected surface by producing first representative measurements corresponding to intensity over a first surface extending across the wave field; means to change the distance between said source and said object, and means to produce second representative measurements corresponding to intensity over said first surface for the changed distance between said object and said source.

74. (Original) An apparatus as claimed in claim 73 wherein said selected surface is one of said spaced apart surfaces.

75. (Previously Presented) An apparatus as claimed in claim 65 including means to directly detecting representative measures of intensity over said spaced apart surfaces.

76. (Previously Presented) An apparatus as claimed in claim 65 wherein said selected surface is spaced apart from said object in the direction of propagation of said radiation.

77. (Previously Presented) An apparatus as claimed in claim 65 wherein said source is substantially a point source.

78. (Previously Presented) An apparatus as claimed in claim 65 wherein said first and second integral transforms are produced using a Fourier transform.

79. (Original) An apparatus as claimed in claim 78 wherein said Fourier transform is a Fast Fourier transform.

80. (Original) A method of phase amplitude imaging including the steps of

(a) irradiating an object with a radiation wave field;

(b) focusing radiation from the object through an imaging system to an imaging surface extending across the wave field;

(c) producing a first representative measure of intensity distribution of radiation over said imaging surface at a first focus of the imaging system;

(d) introducing a change in focus of the image on said imaging surface through the imaging system;

(e) producing a second representative of measure intensity distribution over said imaging surface; and

(f) using said first and second representative measures to produce a representative measure of intensity and a representative measure of rate of change of intensity in the direction of radiation propagation over a selected surface extending across the wave field;

(g) transforming said measure of rate of change of intensity to produce a first integral transform representation and applying to said first integral transform representation a first filter corresponding to the inversion of a first differential operator reflected in said measure of rate of change of intensity to produce a first modified integral transform representation;

(h) applying an inverse of said first integral transform to said first modified integral transform representation to produce an untransformed representation;

(i) applying a correction based on said measure of intensity over said selected surface to said untransformed representation;

(j) transforming the corrected untransformed representation to produce to said second integral transform representation a second integral transform representation and applying a second filter corresponding to the inversion of a second differential operator reflected in the corrected untransformed representation to produce a second modified integral transform representation;

(k) applying an inverse of said second integral transform to said second modified integral transform representation to produce a measure of phase of said radiation wave field across said selected plane.

81. (Original) A method as claimed in claim 80 wherein said radiation wave field has a numerical aperture smaller than the numerical aperture of said imaging system.

82. (Previously Presented) A method as claimed in claim 80 said first focus of the imaging system produces an infocus image at the imaging surface and said second focus of the imaging system produces a slightly defocused image at the imaging surface.

83. (Previously Presented) A method as claimed in claim 80 wherein said imaging surface is substantially planar.

84. (Previously Presented) A method as claimed in claim 80 wherein the imaging surface is an intensity detector.

85. (Previously Presented) A method as claimed in claim 80 wherein said imaging surface is said selected surface.

86. (Previously Presented) A method as claimed in claim 80 wherein said integral transform is a Fourier transform.

87. (Original) A method as claimed in claim 86 wherein said Fourier transform is a Fast Fourier transform.

88. (Previously Presented) A method as claimed in claim 80 wherein said representative measure of rate of change of intensity is produced by subtraction of said first and second representative measurements of intensity.

89. (Previously Presented) A method as claimed in claim 80 wherein said representative measures of intensity and rate of change of intensity are obtained by sampling measurements at selected location over said imaging surface.

90. (Original) A method as claimed in claim 89 wherein said sampling measurements are made at locations defining a regular array over said imaging surface.

91. (Original) A method as claimed in claim 87 wherein said radiation wave field propagates in a z-direction of a cartesian co-ordinate system and further including the step of producing an x component and a y component of phase separately.

92. (Original) A method as claimed in claim 91 wherein said first and said second filters have a component Ω_x for producing the x component of phase and a component Ω_y for producing the y component of phase of the form

$$\Omega_x = \frac{(k_x^2 + k_y^2)k_x}{(k_x^2 + k_y^2)^2 + \alpha k_x^2}$$

$$\Omega_y = \frac{(k_x^2 + k_y^2)k_y}{(k_x^2 + k_y^2)^2 + \alpha k_y^2}$$

where k_x, k_y are the Fourier variables conjugate to x and y;

α is a constant determined by noise in the intensity measurements.

93. (Original) A method as claimed in claim 92 including the step of multiplying said representative measure of rate of change of intensity by the negative of the average wave number of the radiation before said integral trasnformation.

94. (Original) An apparatus for phase amplitude imaging of an object including

a radiation wave field source to irradiate said object;

an imaging system to focus radiation from said object to an imaging surface extending across the wave field propagating from the object;

means to produce a representative measure of radiation intensity over said imaging surface;

said imaging system including selectively operable means to adjust said focus of said radiation to said imaging surface to at least at a first focus and a second focus;

processing means to:

(i) produce a representative measure of intensity and a representative measure of rate of change of intensity in the direction of radiation propagation over a selected surface extending across the wave field from representative measures of radiation intensity over said image surface at said first focus and said second focus;

(ii) transform said measure of rate of change of intensity to produce a first integral transform representation;

(iii) apply to said first integral transform representation a first filter corresponding to the inversion of a first differential operator reflected in said measure of rate of change of intensity to produce a first modified integral transform representation;

(iv) apply an inverse of said first integral transform to said first modified integral transform representation to produce an untransformed representation;

(v) apply a correction based on said measure of intensity over said selected surface to said untransformed representation;

(vi) transform the corrected untransformed representation to produce a second integral transform representation;

(vii) apply to said second integral transform representation a second filter corresponding to the inversion of a second differential operator reflected in the corrected untransformed representation to produce a second modified integral transform representation; and

(viii) apply an inverse of said second integral transform to said second modified integral transform representation to produce a measure of phase of said radiation wave field across said selected plane.

95. (Original) An apparatus as claimed in claim 94 wherein said radiation wave field has a numerical aperture smaller than the numerical aperture said imaging system.

96. (Previously Presented) An apparatus as claimed in claim 94 said first focus of the imaging system produces an infocus image at the imaging surface and said second focus of the imaging system produces a slightly defocused image at the imaging surface.

97. (Previously Presented) An apparatus as claimed in claim 94 wherein said imaging surface is substantially planar.

98. (Previously Presented) An apparatus as claimed in claim 94 wherein the imaging surface is an intensity detector.

99. (Previously Presented) An apparatus as claimed in claim 94 wherein said imaging surface is said selected surface.

100. (Previously Presented) An apparatus as claimed in claim 94 wherein said integral transform is a Fourier transform.

101. (Original) An apparatus as claimed in claim 100 wherein said Fourier transform is a Fast Fourier transform.

102. (Previously Presented) An apparatus as claimed in claim 94 wherein said representative measure of rate of change of intensity is produced by subtraction of said first and second representative measurements of intensity.

103. (Previously Presented) An apparatus as claimed in claim 94 wherein said representative measures of intensity and rate of change of intensity are obtained by sampling measurements at selected location over said imaging surface.

104. (Previously Presented) An apparatus as claimed in claim 103 wherein said sampling measurements are made at location defining a regular array over said imaging surface.

105. (Amended) An apparatus as claimed in claim 101 wherein said radiation wave field propagates in a z-direction of a ~~cartesian~~Cartesian co-ordinate system and further including the step of producing an x component and a y component of phase separately.

106. (Previously Presented) An apparatus as claimed in claim 105 wherein said first and said second filters have a component Ω_x for producing the x component of phase and a component Ω_y for producing the y component of phase of the form

$$\Omega_x = \frac{(k_x^2 + k_y^2)k_x}{(k_x^2 + k_y^2)^2 + \alpha k_x^2}$$

$$\Omega_y = \frac{(k_x^2 + k_y^2)k_y}{(k_x^2 + k_y^2)^2 + \alpha k_y^2}$$

where k_x, k_y are the Fourier variables conjugate to x and y;

α is a constant determined by noise in the intensity measurements.

107. (Previously Presented) A method as claimed in claim 106 including the step of multiplying said representative measure of rate of change of intensity by the negative of the average wave number of the radiation before said integral transformation.

108. (Canceled)

109. (Canceled)